Social Science & Medicine 147 (2015) 296–299

Contents lists available at ScienceDirect

Social Science & Medicine

journal homepage: www.elsevier.com/locate/socscimed

Short communication

Long-term impact of the 2011 Great East Japan Earthquake and tsunami on functional disability among older people: A 3-year longitudinal comparison of disability prevalence among Japanese municipalities

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ARTICLE INFO

Article history:
Received 26 August 2015
Received in revised form
29 October 2015
Accepted 10 November 2015
Available online 1 December 2015

Keywords:
Disability
Disaster
Japan
Municipality
Ecological study

ABSTRACT

It has been unclear whether the prevalence of disability is higher in an area affected by natural disaster than in other areas even if more than one year has passed since the disaster. The aim of this ecological study was to examine whether the rate of increase in disability prevalence among the older population was higher in disaster-stricken areas during the 3 years after the Great East Japan Earthquake (GEJE) and tsunami. This analysis used public Long-term Care Insurance (LTCI) data covering 1570 municipalities. "Disaster areas" were considered to be the three prefectures most affected by the earthquake and tsunami: Iwate, Miyagi, and Fukushima. The outcome measure was the number of aged people (≥65 years) with LTCI disability certification. Rates of change in disability prevalence from January 2011 to January 2014 were used as the primary outcome variable, and compared by analysis of covariance between "coastal disaster areas", "inland disaster areas" and "non-disaster areas". The mean rate of increase in disability prevalence in coastal (14.7%) and inland (10.0%) disaster areas was higher than in non-disaster areas (6.2%) ($P < 0.001$). During the 3 years after the earthquake, the increase of disability prevalence from before the GEJE continued to be higher in the disaster-stricken areas.

1. Introduction

Natural disasters affect functional status among older people. The Great East Japan Earthquake (GEJE) and tsunami on March 11, 2011, directly caused more than 15,000 deaths, but also affected the functional status of older survivors (Ishigaki et al., 2013). Our previous study showed that the prevalence of functional disability increased steeply during the one year after the GEJE, especially in the coastal disaster areas most severely affected by the disaster (Tomata et al., 2014).

Currently, even 3 years after the GEJE, about 315,000 people still remain at evacuation sites (Ishigaki et al., 2013). Previous studies have indicated that such relocated individuals tend to have psychological morbidity and physical inactivity (Murakami et al., 2014; Uscher-Pines, 2009). Therefore, there has been some concern that disability prevalence will continue to increase in the disaster-stricken areas. However, to our knowledge, no study has yet reported this long-term impact of the GEJE.

The aim of this ecological study was to test the hypothesis that the increase in the rate of disability prevalence among the older

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http://dx.doi.org/10.1016/j.socscimed.2015.11.016

population was higher in the disaster-stricken areas than in other areas of Japan, after more than one year had passed after the GEJE. For this purpose, we analyzed Japanese national statistical data covering a period of 3 years after the disaster.

2. Methods

2.1. Study design

The authors performed an ecological study using data from the Report on the Status of the Long-term Care Insurance (LTCI) Project, issued by the Ministry of Health, Labour and Welfare of Japan (Ministry of Health). The Report on the Status of the (LTCI) Project is based on a routine survey conducted on data from all Japanese municipalities.

To confirm whether the changes that occurred in the 3-year period after the GEJE were particularly bigger than those that had occurred in the one-year period before it, statistical data for the 50 months from January 2010 to February 2014 were collected. These data included the status of municipalities at the end of each month.

2.2. Outcome

Functional disability was defined according to disability certification in the LTCI system. Disability prevalence (%) in each municipality every month was calculated as the "number of persons who were certified for LTCI/number of insured elderly population aged ≥65 years".

The LTCI is a mandatory form of social insurance designed to assist the frail elderly in their daily activities (Tsutsui and Muramatsu, 2005). Every person aged >65 years is eligible for formal caregiving services. A person must be certified according to the nationally uniform standard to receive caregiving services through the LTCI system.

2.3. Statistical analysis

All municipalities in Japan which were included in the LTCI system as of February 2014 (n = 1579) were defined as the study subjects.

In the present study, "disaster areas" were defined as municipalities in the prefectures of Iwate, Miyagi, and Fukushima, which were extensively damaged by the GEJE (Ishigaki et al., 2013). Furthermore, the disaster areas were classified into "coastal disaster areas" (municipalities bordering the Pacific coast) and "inland disaster areas" for assessing the damage caused by the tsunami, in common with the previous study (Tomata et al., 2014). Additionally, "non-disaster areas" were defined as the municipalities in the other 44 prefectures in Japan.

The municipalities were excluded if any data necessary for the main analysis were missing because the damage caused by the GEJE was particularly great and no statistical information was available because regional government offices were temporarily non-functional (n = 7. These municipalities included 13,621 insured elderly persons [0.05% of all insured elderly persons in all the municipalities]). As a result, a total of 1572 municipalities were included in the main analysis.

Because these excluded municipalities did not meet this exclusion criterion when we used only two data points (January 2011 and January 2014), we also conducted sensitivity analysis using all of the municipalities (n = 1579).

The primary outcome was the annual rate of change in disability prevalence from January 2011 to January 2014.

To check whether the degree of increase in the prevalence of disability was higher in the disaster-stricken areas at each point, we compared the rates of change in disability prevalence for every one-year period between each of the years.

3. Results

3.1. Baseline characteristics

The baseline characteristics in January 2011 were as follows (Table 1). The mean number of insured elderly persons aged ≥65 years was 19,346 in the coastal disaster areas, 9787 in the inland disaster areas, and 18,969 in the non-disaster areas (P = 0.135 by ANOVA). The mean disability prevalence was 16.0% in the coastal disaster areas, 16.5% in the inland disaster areas, and 16.7% in the non-disaster areas (P = 0.399 by ANOVA).

3.2. Three-year change in disability prevalence

As shown in Table 2, the mean rate of increase in disability prevalence differed significantly among the area groups at 2 years and 3 years later ($P < 0.001$). In the 3 years after the GEJE, the rate of increase in disability prevalence was significantly higher in coastal (14.7%) and inland (10.0%) disaster areas than in non-disaster areas (6.2%) (post-hoc univariate analysis by Dunnett's t test; $P < 0.001$).

We compared the rates of change in disability prevalence for every one-year period between each of the years, and the differences between groups (*F*-value) decreased with each passing year (Table S1). The rate of increase in coastal disaster areas tended to be higher than in non-disaster areas at each point, but the mean rates between January 2013 and January 2014 did not differ significantly (post-hoc univariate analysis by Dunnett's t test; $P = 0.176$).

Because the excluded municipalities did not meet this exclusion criterion when we used only two data points (January 2011 and January 2014), we also conducted sensitivity analysis using all of the municipalities (n = 1579). In the 3 years after the GEJE, the rate of increase in disability prevalence in coastal disaster areas was 18.5% (Table S2).

3.3. Fifty-month change in disability prevalence

Disability prevalence increased in each region between January 2010 and February 2014 (Fig. 1). In this analysis, the sample size was n = 1526 municipalities (among 1572 municipalities, some were excluded if: 1) any data from January 2010 to February 2014 had been rendered unavailable [n = 8]; 2) data had been recorded using the classification system employed before April 2006 [n = 2]; or 3) the outcome variable [mild disability or moderate to severe disability] when stratified by the age structure of the population [65–74 years or ≥75 years] was 0% at any point, because it was a village with a particularly small population [n = 36]).

Even more than one year after the disaster, disability prevalence in coastal disaster areas tended to increase.

4. Discussion

The aim of this ecological study was to examine whether the increase in the rate of disability prevalence among the older population during the 3 years after the GEJE was higher in the disaster-stricken areas, relative to other areas of Japan. This analysis showed that disability prevalence in disaster-stricken areas increased more markedly during the 3 years after the GEJE, especially in coastal disaster areas where the damage due to the tsunami had been especially serious. However, the difference in the degree of increase in disability prevalence between the disaster-stricken and non-disaster areas tend to shrink year by year (Table S1).

Table 1
Characteristics of municipalities on baseline (January 2011) according to regions (n = 1572).

	Coastal disaster areas (n = 29)		Inland disaster areas (n = 82)		Non-disaster areas (n = 1461)		p^b	F^b
	Mean	SD	Mean	SD	Mean	SD		
Number of insured elderly persons	19,346	36,787	9787	14,086	18,969	41,493	0.135	2.0
Proportion of persons ≥75 y (%)[a]	52.3	3.7	57.7	5.2	52.4	7.1	<0.001	22.1
Prevalence of disability (%)	16.0	1.2	16.5	2.0	16.7	2.9	0.399	0.9

[a] Proportion per all insured elderly persons (≥65 y).
[b] Parameters of one-way ANOVA (p-value and F-value. Degrees of freedom = 2).

Table 2
Regional comparisons of rates of change in disability prevalence during the three years following the month before the Great East Japan Earthquake (n = 1572 municipalities).[a]

	n	1-year later				2-years later				3-years later			
		Mean	(95%CI)	p	F	Mean	(95%CI)	p	F	Mean	(95%CI)	p	F
Coastal disaster areas[b]	29	9.2	(7.9–10.5)	<0.001	44.9	12.1	(10.0–14.2)	<0.001	37.1	14.7	(12.1–17.2)	<0.001	30.2
Inland disaster areas	82	4.2	(3.4–5.0)			8.7	(7.5–10.0)			10.0	(8.4–11.5)		
Non-disaster areas	1461	2.9	(2.7–3.1)			5.0	(4.7–5.3)			6.2	(5.9–6.6)		

[a] Rate (%) of change in disability prevalence from January 2011. Adjusted means and 95% confidence interval (95%CI) of means were estimated by analysis of covariance (degrees of freedom = 2) based on mean proportion of individuals aged ≥75 years at the baseline (52.7%).
[b] Disaster areas were defined as the three prefectures most severely impacted by the disaster (Iwate, Miyagi and Fukushima). "Coastal" means municipalities located on the Pacific coast where the tsunami struck on March 11, 2011.

A limitation of the previous study had been that post-disaster data during the one year after the GEJE for the 15 municipalities where the damage had been particularly great were not obtained, because regional government offices had not been functional after the disaster (Tomata et al., 2014). The main analysis of this study (Table 2) also excluded a proportion of these municipalities (n = 7) to include the changes that had occurred over one year. However, the disability prevalence data for these municipalities were finally reported more than one year after the GEJE. Therefore the present study was able to include all of the municipalities in the sensitivity analysis to compare rates of change in disability prevalence from January 2011 to January 2014 (Table S2), and the results can be interpreted without any underestimation resulting from incomplete sampling. The sensitivity analysis showed that the mean rate

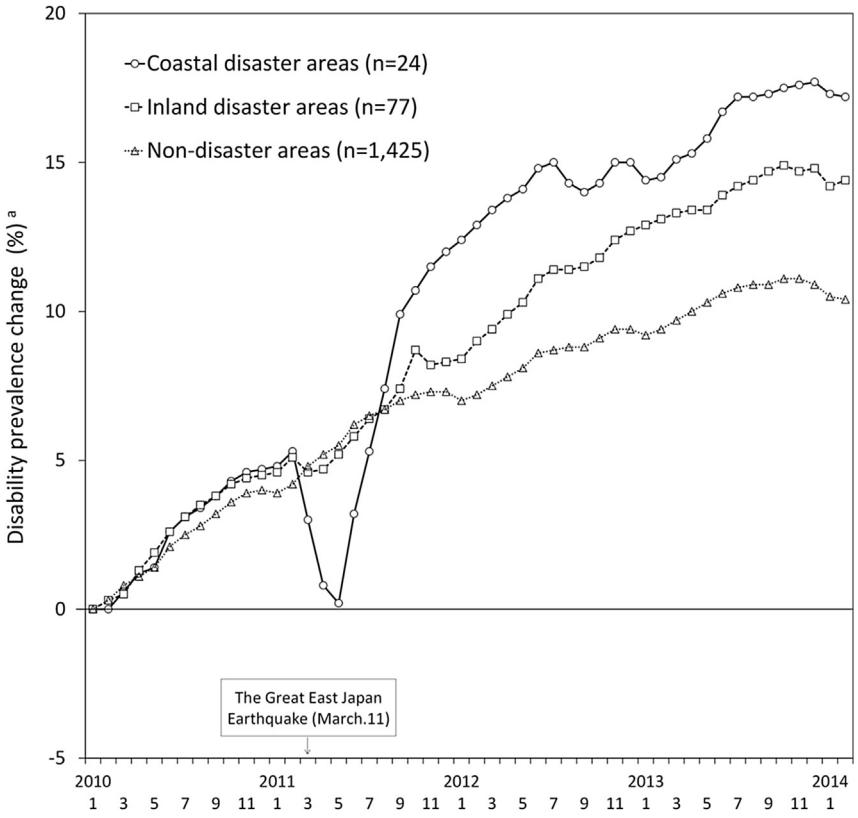

Fig. 1. Monthly trends in disability prevalence before and after the Great East Japan Earthquake (n = 1526 municipalities). (a) Adjusted means were estimated by analysis of covariance (adjustment item: proportion of individuals aged ≥75 years at the baseline). The estimations were based on the average of the adjustment item (proportion of individuals aged ≥75 years = 51.1%).

of increase in disability prevalence among coastal disaster areas was higher than that obtained in the main analysis (18.5% in Table S2 and 14.7% in Table 2), because municipalities excluded in the main analysis had marked increases in disability prevalence after the GEJE. This result suggested that the results of our previous study (Tomata et al., 2014) and the main analysis in the present study had been underestimated.

Although the mortality rate in disaster-stricken areas did not increase further beyond 6 months after the GEJE (Uchimura et al., 2014), the suicide rate increased after the 2-year mark (Orui et al., 2015). Therefore the aftermath of the GEJE appeared to extend beyond one year.

This study had several limitations, including the possibility of confounding by personal and local characteristics, as this was an ecological study.

5. Conclusions

The GEJE was a Japanese disaster of historical proportions, and even more than one year later, the increase of disability prevalence continued to be higher in disaster-stricken areas than those before the event.

Acknowledgments

We would like to thank Kuniko Abe, Fukuko Kano, Yukiko Asano, Yoshiko Nakata, Yumi Tamura, and Mami Takahashi for their technical assistance.

Appendix A. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.socscimed.2015.11.016.

Competing interests

None to declare.

Funding

This work was supported by Health Sciences Research grants (H24-Toukei-Ippan-006, H25-Kenki-Shitei-002[fukkou]) from the Ministry of Health, Labour and Welfare of Japan.

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